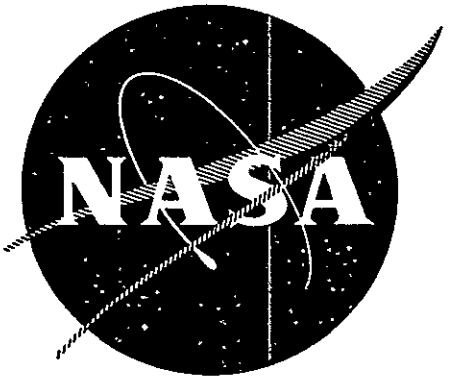

INITIAL EVALUATION TESTS OF GENERAL ELECTRIC COMPANY 12.0 AMPERE-HOUR NICKEL-CADMIUM SPACECRAFT CELLS WITH DESIGN VARIABLES

prepared for

GODDARD SPACE FLIGHT CENTER

Contract S-57075AG

WEAPONS QUALITY ENGINEERING CENTER
NWSC Crane, Indiana

DEPARTMENT OF THE NAVY
NAVAL WEAPONS SUPPORT CENTER
WEAPONS QUALITY ENGINEERING CENTER
CRANE, INDIANA 47522

INITIAL EVALUATION TESTS OF GENERAL ELECTRIC COMPANY 12.0 AMPERE-HOUR NICKEL-CADMIUM SPACECRAFT CELLS WITH DESIGN VARIABLES

WQEC/C 79-114

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REPORT BRIEF
INITIAL EVALUATION TESTS
OF
GENERAL ELECTRIC COMPANY
12.0 AMPERE-HOUR NICKEL-CADMIUM SPACECRAFT CELLS
WITH
DESIGN VARIABLES

Ref: (a) NASA Purchase Order S-57075AG
(b) Initial Evaluation Test Procedure for Nickel-Cadmium Sealed Space Cells: NAD 3053-TP324; 10 Apr 1973

I. TEST ASSIGNMENT BRIEF

A. The purpose of this evaluation test program is to insure that all cells put into the life cycle program are of high quality by the screening of cells found to have electrolyte leakage, internal shorts, low capacity, or inability of any cell to recover its open-circuit voltage above 1.150 volts during the internal short test.

B. The fifty-two cells were provided by the National Aeronautics and Space Administration, Goddard Space Flight Center (GSFC), to NAVWPNSUPPCEN Crane for evaluation of the various cell design variables, incorporated in these cells, on a near-earth orbit test regime. The cells were manufactured by the General Electric Company, under NASA Contracts NAS-5-23783 and S-52734-B, according to NASA Specification S-711-P-6 and General Electrics' Manufacturing Control Document (MCD) 232A2222AA-54. The design variable cells were divided into nine groups (1 through 9) of six cells each except for Groups 3 and 9, which only had 5 cells. The cells were identified by the manufacturer's catalog numbers 42B012AB29-G1 and G2, except for Group 9, which had catalog number 42B012EB01. These cells are rated at 12.0 ampere-hours, contain dual, nickel-braze ceramic seals, and the G2 type cells (31) and two cells from Group 9, have pressure transducers. Testing was funded in accordance with reference (a).

C. Test limits specify those values at which a cell is to be terminated from charge or discharge. Requirements are referenced to as normally expected values based on past performance of aerospace nickel-cadmium cells with demonstrated life characteristics. A requirement does not constitute a limit for discontinuance from test.

II. SUMMARY OF RESULTS

A. Each group of cells, on the average, indicated a slight increase in plate stack thickness following test, except Group 2 which indicated no change.

B. No limits or requirements were exceeded by any of the Group 2 cells which have Teflon treated negative plates.

C. All the cells from Groups 7 and 8 exceeded the 1.480 voltage requirement during the C/10 charges at the 20 and 25° C temperatures. They also exceeded the 1.560 voltage test limit during the 0° C overcharge test.

D. Sixteen cells from Groups 1, 5 and 6 exceeded the 1.480 voltage requirement during the C/10 charges at 20° C and one cell from Group 3 exceeded the 65 psia pressure requirement during the second charge at this temperature.

E. One cell's voltage, from Group 9, was 8 millivolts less than the average voltage of the group at the end of the 1-week open-circuit period during the charge retention test.

F. Eighteen cells from Groups 1, 3, 4 and 5 exceeded the 1.520 voltage requirement during the 0° C overcharge test and 3 cells, from Group 6, exceeded the pressure requirement of 65 psia.

G. The cells from Groups 8 and 9 delivered less (52%) than the requirement of 55% of the input during the 20° C charge efficiency test.

H. During the pressure versus capacity tests, one cell each, from Groups 7 and 8, reached the 1.550 cut-off voltage before reaching the 20 psia cut-off pressure.

III. RECOMMENDATIONS

A. It was recommended that these cells be placed on a near-earth orbit life test regime.

B. In February 1979, eight 5-cell packs (Packs 3D through 3K, corresponding to Groups 1 through 8) began life test on a 1.48-hour orbit (1.00-hour charge with a voltage limit control at 20° C and a depth-of-discharge of 40%). The Group 9 cells (Pack 3L) began life test in August 1979 with the same test regime.

RESULTS OF INITIAL EVALUATION TESTS OF GENERAL ELECTRIC COMPANY 12.0 AMPERE-HOUR NICKEL-CADMIUM SPACECRAFT CELLS WITH DESIGN VARIABLES

I. TEST CONDITIONS AND PROCEDURE

A. All evaluation tests were performed at room ambient (RA) pressure and temperature (25° ± 2° C), with discharges at the 2-hour rate, and in accordance with reference (b), unless otherwise specified, and consisted of the following:

1. Phenolphthalein leak tests (2).

2. Three capacity tests, third at 20° C; with internal resistance measurements during second charge/discharge.

3. Auxiliary electrode characterization test.

4. Charge retention test, 20° C.

5. Internal short test.

6. Charge efficiency test, 20° C.

7. Overcharge tests, 0° and 35° C.

8. Pressure versus capacity test.

9. Phenolphthalein leak test.

(See Appendix I for summary of test procedure.)

II. CELL IDENTIFICATION AND DESCRIPTION

A. The cells from Groups 1 through 8 were identified by the manufacturers' catalog number 42B012AB29-G1 and G2, in which the G2 cells have pressure transducers, and those from Group 9 had catalog number 42B012EB01. The serial numbers and design variable notations were as follows:

Group	Design Variable Notation	Serial Number
1	LT/NY/O	02470285-GR1-01 to 06-L01
2	LT/NY/TFE	02470285-GR2-01 to 06-L01
3	LT/NY/AG	02470285-GR3-01 to 05-L01
4	LT-LT/NY/O	02480286-GR4-01 to 06-L02
5	PPLT/NY/O	02490287-GR5-01 to 06-L03
6	LT/POLY/O	02470285-GR6-01 to 06-L01
7	AK-68/NY/O	02500288-GR7-01 to 06-L04
8	AK/NY/O	02500288-GR8-01 to 06-L04
9	Post 31028 SP-2	02970321-----01 to 05-L01

The cells were placed in temporary pack configurations for initial testing in which each cell was individually restrained. The pack numbers were 548X through 554X. Pressure transducers were fitted on four cells of each group except Group 3, which was fitted with three.

B. The 12.0 ampere-hour cell is rectangular with an average overall height of 4.559 inches, width of 2.987 inches and edge thickness of .892 inches.

C. The cell containers and covers are made of stainless steel with a nominal case wall thickness of .019 inches. The positive and negative terminals are insulated from the cell cover by dual, nickel-braze, ceramic-to-metal seals and protrude through the cover as solder-type terminals.

D. Cell serial number 06 of each group contains a standard Aerospace auxiliary electrode and cell serial number 05 of each group contains a Heart Pacer type auxiliary electrode.

E. The description of the cell design variables are contained in Table I.

III. RESULTS - The following was condensed from Tables II through IX.

A. Each group of cells, on the average, indicated a slight increase in plate stack thickness following test, except Group 2 which indicated no change.

B. No limits or requirements were exceeded by any of the Group 2 cells.

C. Limits/requirements exceeded during the change portion of the testing are as follows:

Test	Limits/Requirements Exceeded	Group* #1	#3	#4	#5	#6	#7	#8
Charge, C/10, 24 hrs @ 25° C	1.480 volts						6 (1.486)	6 (1.487)
Charge, C/10, 24 hrs @ 20° C	1.480 volts	6 (1.483)			6 (1.482)	4 (1.481)	6 (1.515)	6 (1.512)
Charge, C/10, 24 hrs @ 20° C (Second charge at this temperature)	1.480 volts	6 (1.482)			6 (1.484)	6 (1.482)	6 (1.507)	6 (1.511)
	65 psia							
Charge, C/20, 60 hrs @ 0° C	1.520 volts	6 (1.534)	4 (1.523)	2 (1.520)	6 (1.533)			
	1.560 volts for 2 hours						6	6
	65 psia					3	3	2

*Number under column indicates number of cells in that group which exceeded the designated test limit and the value in parenthesis indicates the average peak voltage for those cells during test.

D. One cell's voltage, from Group 9, was 8 millivolts less than the average voltage of the group at the end of the 1-week open-circuit period during the charge retention test.

E. The cells from Groups 8 and 9 delivered less (52%) than the requirement of 55% of the input capacity during the 20° C charge efficiency test.

F. During the pressure versus capacity tests, one cell each, from Groups 7 and 8, reached the 1.550 cut-off voltage before reaching the 20 psia cut-off pressure.

G. The auxiliary electrode characteristic test was performed on the cells from Groups 1, 4, 7 and 8. Maximum signal power was obtained with resistances of 5 to 10-ohms on cell 5 (Heart Pacer type) of each group and with resistances of 50 to 1000-ohms on cell 6 (standard Aerospace type). A 10-ohm and 300-ohm resistance was used throughout the test on cells 5 and 6 respectively, as instructed by Goddard Space Flight Center's Technical Officer.

TABLE I

CELL DESIGN VARIABLES

VARIABLE	GROUP#	TYPICAL POSITIVE THICKNESS CM	TYPICAL NEGATIVE THICKNESS	POSITIVE LOADING gm/dm^3 OF SINTER	NEGATIVE LOADING gm/dm^3 OF SINTER	FINAL KOH QUANTITY CC N/V 3rd	PRECHARGE[2] ADJUST Ah
Control [1]	1	.069	.079	2095	2180	40/40	4.6
Teflon Treatment	2	.069	.079	2095	2180	48/49	4.6
Silver Treatment	3	.069	.079	2095	2180	43/44	4.6
Light Loading	4	.069	.079	1840	1833	45/46	4.6
No PQ Treatment	5	.069	.079	2113	2180	40.3/41.5	4.6
Polypropylene Separator	6	.069	.079	2095	2180	39/40	4.6
A.K. Plate-1968 Design, No Cad. Old Ect Process, No Decarb Process	7	.081 (Unsized)	.066	2130	2542	38/39	0
A.K. Plate-1968 Design, No Cad. Present Aerospace Cell Process	8	.081 (Unsized)	.066	2130	2542	39/40	1.8
Electrochemical Impregnated Positives	9	.074	.079	1276[3]	2280	48	5.8

(1) Control Cell Represents Present Aerospace Design and Processes with no Extra Treatments: Non-Woven Nylon Separator, PQ Treated Positives, Decarbonation Process, IUE Loading Levels, 31 percent KOH.

(2) Based on 228cc O^2/Ah.

(3) By hydrate pick-up, not hydrate reduction.

TABLE II

Initial Evaluation Test Averages

Change	Group 1 Volts	psia	ah Out	Group 2 Volts	psia	ah Out	Group 3 Volts	psia	ah Out
C/20 for 48 hrs @ 25° C	1.453	16	16.1	1.437	19	15.5	1.441	18	16.0
C/10 for 24 hrs @ 25° C	1.460	37	15.3	1.453	35	14.8	1.455	41	15.0
C/10 for 24 hrs @ 20° C	1.469	48	14.8	1.461	42	14.2	1.466	56	14.4
C/10 for 24 hrs @ 20° C*	1.470	56	13.5	1.463	39	13.0	1.470	55	13.5
C/40 for 20 hrs @ 20° C**	1.372	4	3.7	1.373	7	4.6	1.373	6	4.2
C/20 for 60 hrs @ 0° C	1.496	45	14.5	1.483	36	13.9	1.493	44	14.6
C/10 for 24 hrs @ 35° C	1.418	37	15.9	1.417	17	16.1	1.417	31	15.9
Open-Circuit									
End-of-1 week*	1.326	4		1.332	8		1.329	6	
24 hrs after 16-hr short period	1.250	4		1.257	7		1.250	6	

	Group 4 Volts	psia	ah Out	Group 5 Volts	psia	ah Out	Group 6 Volts	psia	ah Out
C/20 for 48 hrs @ 25° C	1.441	20	14.3	1.447	13	16.3	1.443	16	16.1
C/10 for 24 hrs @ 25° C	1.457	29	13.7	1.455	26	16.0	1.458	39	15.5
C/10 for 24 hrs @ 20° C	1.466	34	13.6	1.466	52	15.0	1.471	66	15.1
C/10 for 24 hrs @ 20° C*	1.467	42	12.5	1.468	58	13.7	1.475	77	13.8
C/40 for 20 hrs @ 20° C**	1.376	10	3.9	1.375	4	4.1	1.374	6	4.3
C/20 for 60 hrs @ 0° C	1.491	37	13.1	1.506	37	14.8	1.497	69	14.8
C/10 for 24 hrs @ 35° C	1.423	35	14.1	1.402	34	14.1	1.415	24	16.0
Open Circuit									
End-of-1 week*	1.319	10		1.315	5		1.330	6	
24 hrs after 16-hr short period	1.238	10		1.259	4		1.247	6	

	Group 7 Volts	psia	ah Out	Group 8 Volts	psia	ah Out	Group 9 Volts	psia	ah Out
C/20 for 48 hrs @ 25° C	1.452	14	18.6	1.452	14	15.7	1.446	32	10.7
C/10 for 24 hrs @ 25° C	1.463	30	18.0	1.463	29	18.1	1.435	32	10.1
C/10 for 24 hrs @ 20° C	1.477	26	17.7	1.480	34	17.8	1.444	40	10.1
C/10 for 24 hrs @ 20° C*	1.477	37	15.2	1.480	40	15.4	1.443	36	9.0
C/40 for 20 hrs @ 20° C**	1.370	6	3.6	1.369	9	3.1	1.377	12	3.1
C/20 for 60 hrs @ 0° C	1.578	68	16.8	1.581	66	16.1	1.494	46	10.2
C/10 for 24 hrs @ 35° C	1.396	52	14.5	1.397	40	14.7	1.395	26	9.4
Open-Circuit									
End-of-1 week*	1.308	7		1.308	11		1.294	13	
24 hrs after 16-hr short period	1.263	6		1.259	9		1.236	12	

*Charge Retention Test
**Charge Efficiency Test, 6.0 ah input

TABLE III

MEASUREMENT AND LEAK TEST DATA

	SERIAL NUMBER	WEIGHT (Grams)	HEIGHT (Inches)	LENGTH (Inches)			WIDTH (Inches)	PHENOLPHTHALEIN LEAK TESTS								
				EDGE MINIMUM	CENTER MAXIMUM (Pre-Test)	CENTER MAXIMUM (Post-Test)		INITIAL			POST HI VAC			POST TEST		
								Terminals		Other	Terminals		Other	Terminals		Other
								+	-		+	-		+	-	
Group 2	001	769.6 *	4.559	.893	.898	.895	2.993									
	002	520.3	4.553	.893	.893	.898	2.992									
	003	509.5	4.554	.898	.896	.899	2.991									
	004	770.2 *	4.543	.893	.894	.897	2.987									
	005	774.3 *	4.544	.890	.898	.898	2.987									
	006	774.4 *	4.544	.890	.893	.893	2.986									
Group 4	001	767.3 *	4.549	.892	.899	.893	2.991									
	002	509.7	4.565	.891	.890	.894	2.991									
	003	509.1	4.563	.895	.893	.895	2.989									
	004	760.4 *	4.547	.895	.900	.893	2.986									
	005	765.4 *	4.539	.890	.891	.890	2.999									
	006	762.0 *	4.548	.891	.891	.895	2.991	NO	LEAKS		NO	LEAKS		NO	LEAKS	
Group 7	001	771.0 *	4.539	.898	.919	.911	2.983									
	002	773.4 *	4.549	.897	.909	.915	2.985									
	003	519.6	4.549	.896	.906	.922	2.984									
	004	521.6	4.553	.891	.917	.929	2.984									
	005	778.0 *	4.545	.899	.916	.923	2.987									
	006	777.8 *	4.535	.899	.932	.919	2.995									
Group 8	001	521.0	4.557	.894	.910	.916	2.983									
	002	770.8 *	4.552	.892	.916	.922	2.987									
	003	519.3	4.553	.896	.912	.919	2.981									
	004	767.8 *	4.556	.892	.920	.911	2.984									
	005	774.8 *	4.541	.896	.909	.928	2.967									
	006	772.9 *	4.557	.891	.909	.922	2.984									
	*-	HAS PRESSURE TRANSDUCER														

TABLE III

MEASUREMENT AND LEAK TEST DATA

	SERIAL NUMBER	WEIGHT (Grams)	HEIGHT (Inches)	LENGTH (Inches)			WIDTH (Inches)	PHENOLPHTHALEIN LEAK TESTS								
								INITIAL			POST HI VAC			POST TEST		
				EDGE MINIMUM	CENTER MAXIMUM (Pre-Test)	CENTER MAXIMUM (Post-Test)		Terminals		Other	Terminals		Other	Terminals		Other
								+	-		+	-		+	-	
Group 2	001	538.8	4.560	.891	.898	.898	2.989									
	002	534.5	4.571	.890	.898	.898	2.989									
	003	793.6 *	4.559	.899	.902	.902	2.990									
	004	789.6 *	4.560	.895	.902	.902	2.989									
	005	791.6 *	4.561	.897	.898	.898	2.991									
	006	790.5 *	4.564	.895	.898	.898	2.989									
8 Group 3	001	524.1	4.567	.891	.901	.903	2.989									
	002	790.7 *	4.564	.893	.904	.904	2.992									
	003	775.4 *	4.583	.891	.895	.896	2.984									
	004	524.6	4.563	.889	.898	.904	2.987									
	005	783.7 *	4.567	.894	.902	.905	2.987									
								NO	LEAKS		NO	LEAKS		NO	LEAKS	
Group 5	001	766.6 *	4.577	.895	.902	.903	2.982									
	002	516.3	4.576	.892	.902	.903	2.985									
	003	772.3 *	4.571	.897	.904	.904	2.984									
	004	516.4	4.576	.889	.902	.904	2.986									
	005	770.8 *	4.561	.889	.898	.901	2.985									
	006	768.4 *	4.560	.891	.897	.900	2.984									
Group 6	001	520.0	4.563	.896	.897	.899	2.987									
	002	771.0 *	4.606	.896	.902	.903	2.987									
	003	770.0 *	4.567	.896	.900	.902	2.987									
	004	519.6	4.559	.892	.903	.903	2.987									
	005	774.7 *	4.565	.896	.898	.898	2.984									
	006	775.6 *	4.564	.890	.895	.897	2.987									

* - Has Pressure Transducer

TABLE III

MEASUREMENT AND LEAK TEST DATA

Group 9

SERIAL NUMBER	WEIGHT (Grams)	HEIGHT (Inches)	LENGTH (Inches)			WIDTH (Inches)	PHENOLPHTHALEIN LEAK TESTS								
							INITIAL			POST HI VAC			POST TEST		
			MINIMUM	MAXIMUM (Pre-Test)	MAXIMUM (Post-Test)		Terminals		Other	Terminals		Other	Terminals		Other
							+	-		+	-		+	-	
001	830.8 *	4.567	.911	.925	.928	2.996									
002	808.8 *	4.599	.909	.922	.924	3.002									
003	553.9	4.567	.903	.920	.924	2.998	NO	LEAKS		NO	LEAKS		NO	LEAKS	
004	558.7	4.585	.911	.928	.931	2.995									
005	555.7	4.573	.904	.920	.922	2.999									
* - Has Pressure Transducer															

6

TABLE IV
Capacity Data

	SERIAL NUMBER	Capacity Test 1						Capacity Test 2						Capacity Test 3 (20°C)					
		END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE		
		CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)
Group 2	001	1.456		19	16.4		1	1.462		27	15.3		2	1.469		43	14.6		5
	002	1.456			16.4			1.462			15.3			1.469			14.5		
	003	1.456			16.4			1.462			15.3			1.469			14.6		
	004	1.447		16	15.4		1	1.462		28	15.5		14	1.471		42	15.1		6
	005	1.455	.818	15	16.4	-.086	4	1.457	.623	41	14.9	.152	7	1.468	.593	55	14.6	.154	11
	006	1.447	.541	14	15.4	-.095	10	1.457	.725	51	15.3	.052	3	1.470	.703	53	15.1	.251	19
Group 4	001	1.442		23	14.3		8	1.458		33	13.6		8	1.466		37	13.4		10
	002	1.442			14.3			1.458			13.9			1.467			13.7		
	003	1.441			14.3			1.457			13.6			1.465			13.7		
	004	1.441		15	14.3		10	1.456		25	13.6		11	1.465		30	13.7		11
	005	1.441	.813	24	14.3	-.039	12	1.455	.564	30	13.6	-.002	13	1.466	.560	38	13.4	.120	13
	006	1.441	.362	18	14.1	-.015	6	1.456	.396	26	13.6	.061	7	1.467	.390	32	13.7	.143	9
Group 7	001	1.451		22	18.6		5	1.464		35	18.4		9	1.476		45	17.7		16
	002	1.450		17	18.6		7	1.464		33	18.4		12	1.476		49	17.7		21
	003	1.454			18.6			1.465			18.4			1.478			18.0		
	004	1.452			18.4			1.465			17.9			1.476			17.4		
	005	1.452	.750	6	18.6	-.013	0	1.459	.421	21	17.0	.061	0	1.481	.452	27	17.3	.052	7
	006	1.453	.663	12	18.9	.001	5	1.459	.739	31	17.7	.352	11	1.476	.745	37	18.0	.329	17
Group 8	001	1.451			18.8			1.464			18.4			1.477			17.9		
	002	1.453		11	19.1		0	1.470		32	18.6		7	1.489		40	18.0		17
	003	1.449			18.8			1.462			18.4			1.474			17.9		
	004	1.453		14	18.8		6	1.463		32	18.4		10	1.477		38	17.8		17
	005	1.453	.779	16	18.8	.039	6	1.458	.516	25	17.4	.082	8	1.479	.508	27	17.8	.051	10
	006	1.453	.321	16	18.6	-.011	6	1.460	.379	28	17.4	.052	14	1.482	.346	32	17.5	.050	18

9ND-NADC (SP 11/73)

TABLE IV
Capacity Data

	SERIAL NUMBER	Capacity Test 1						Capacity Test 2						Capacity Test 3 (20°C)					
		END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE		
		CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)
Group 2	001	1.438			15.5			1.455			14.7			1.462			14.2		
	002	1.437			15.5			1.452			14.9			1.459			14.2		
	003	1.435		16	15.3		5	1.453		36	14.7		6	1.460		41	14.1		12
	004	1.434		26	15.5		6	1.452		45	14.7		11	1.460		54	14.2		16
	005	1.436	.347	19	15.5	-.006	11	1.452	.456	32	14.9	-.037	11	1.460	.467	39	14.2	.079	12
	006	1.435	.348	14	15.7	-.008	10	1.453	.414	27	14.9	.036	10	1.460	.413	33	14.3	.055	12
Group 3	001	1.442			16.1			1.456			15.2			1.467			14.5		
	002	1.442		20	15.9		6	1.455		52	14.8		9	1.465		65	14.2		14
	003	1.441		21	16.1		10	1.455		37	15.1		11	1.465		53	14.5		14
	004	1.441			15.9			1.456			15.1			1.466			14.5		
	005	1.441	.453	12	15.9	.032	1	1.455	.548	35	14.9	.070	2	1.465	.540	51	14.5	.115	4
Group 5	001	1.446		8	16.3		0	1.454		23	16.0		0	1.464		50	15.0		4
	002	1.448			16.2			1.454			16.0			1.465			15.0		
	003	1.445		16	16.2		5	1.455		32	16.0		6	1.465		61	15.0		10
	004	1.448			16.3			1.455			16.2			1.466			15.0		
	005	1.446	.310	15	16.2	.007	0	1.457	.405	27	16.0	-.004	8	1.468	.366	53	15.0	.050	11
	006	1.447	.460	12	16.3	-.015	3	1.455	.511	23	16.0	-.002	4	1.466	.555	45	15.0	.101	16
Group 6	001	1.441			16.0			1.459			15.6			1.471			14.9		
	002	1.445		15	16.0		6	1.461		57	15.4		6	1.472		95	14.9		19
	003	1.443		26	16.0		12	1.457		43	15.4		12	1.472		83	14.6		16
	004	1.444			16.0			1.458			15.4			1.472			14.6		
	005	1.442	.262	13	16.1	-.002	5	1.457	.409	33	15.4	-.001	3	1.471	.409	56	15.7	.036	4
	006	1.442	.442	10	16.3	-.048	2	1.457	.536	21	15.6	-.074	1	1.470	.553	30	15.9	-.043	2

TABLE IV
Capacity Data

SERIAL NUMBER	Capacity Test 1						Capacity Test 2						Capacity Test 3 (20°C)					
	END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE		
	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)
001	1.449		26	10.4		7	1.438		26	9.8		8	1.444			9.6		11
002	1.446		38	10.8		19	1.437		38	10.0		20	1.446			10.1		22
003	1.444			10.8			1.432			10.2			1.443			10.2		
004	1.444			10.8			1.433			10.2			1.443		34	10.2		
005	1.445			10.8			1.433			10.2			1.443		46	10.2		

TABLE V
INTERNAL RESISTANCE AND SHORT TEST DATA

9ND-NADC (SP 11/73)

	SERIAL NUMBER	INTERNAL RESISTANCE (MILLIOHMS)			INTERNAL SHORT TEST		
		END-OF-CHARGE	ONE HOUR AFTER START-OF-DISCHARGE	TWO HOURS AFTER START-OF-DISCHARGE	AFTER 16 HR SHORT	AFTER 24 HOUR OCV STAND	
					CELL	CELL	PRESS
Group 1	001	2.4	2.3	2.2	.058	1.252	1
	002	2.3	2.3	2.3	.059	1.252	
	003	2.1	2.2	2.2	.058	1.252	
	004	2.3	2.1	2.2	.058	1.250	1
	005	2.3	2.1	2.1	.058	1.249	4
	006	2.2	2.1	2.1	.057	1.247	8
Group 4	001	2.2	2.3	2.2	.017	1.240	9
	002	2.3	2.3	2.2	.020	1.237	
	003	2.2	2.2	2.3	.020	1.240	
	004	2.3	2.3	2.3	.015	1.234	11
	005	2.1	2.2	2.2	.025	1.239	13
	006	2.2	2.2	2.1	.025	1.239	6
Group 7	001	2.3	2.2	2.3	.102	1.264	6
	002	2.4	2.3	2.4	.091	1.264	10
	003	2.4	2.4	2.4	.085	1.262	
	004	2.4	2.3	2.3	.091	1.264	
	005	2.4	2.4	2.4	.088	1.260	0
	006	2.5	2.4	2.4	.095	1.262	7
Group 8	001	2.2	2.1	2.1	.093	1.261	
	002	2.2	2.1	2.1	.091	1.257	6
	003	2.2	2.2	2.2	.084	1.261	
	004	2.2	2.1	2.2	.082	1.257	10
	005	2.3	2.2	2.3	.084	1.261	8
	006	2.3	2.1	2.2	.083	1.259	12

TABLE V
INTERNAL RESISTANCE AND SHORT TEST DATA

9ND-NADC (SP 11/73)

	SERIAL NUMBER	INTERNAL RESISTANCE (MILLIOHMS)			INTERNAL SHORT TEST		
		END-OF-CHARGE	ONE HOUR AFTER START-OF-DISCHARGE	TWO HOURS AFTER START-OF-DISCHARGE	AFTER 16 HR SHORT	AFTER 24 HOUR OCV STAND	
					CELL	CELL	PRESS
Group 2	001	2.6	2.8	2.8	.059	1.258	
	002	2.9	3.0	3.0	.062	1.255	
	003	2.9	2.9	3.0	.057	1.258	4
	004	2.8	3.1	3.0	.061	1.258	5
	005	3.0	3.0	3.1	.062	1.258	11
	006	2.9	3.0	3.1	.066	1.254	9
Group 3	001	2.6	2.7	2.8	.051	1.249	
	002	3.1	3.0	3.1	.050	1.250	6
	003	2.9	3.0	2.9	.057	1.251	10
	004	2.9	3.0	3.1	.060	1.252	
	005	2.8	3.0	3.1	.051	1.248	*1
Group 5	001	2.6	2.8	3.0	.054	1.261	0
	002	3.0	3.1	3.1	.056	1.259	
	003	3.0	3.2	3.1	.047	1.260	5
	004	3.0	3.1	3.1	.049	1.258	
	005	3.0	3.1	3.0	.054	1.259	8
	006	2.9	2.9	3.1	.048	1.256	4
Group 6	001	2.9	2.9	3.0	.057	1.249	
	002	3.4	3.2	3.1	.047	1.248	6
	003	3.1	3.1	3.1	.044	1.251	12
	004	3.4	3.2	3.2	.045	1.251	
	005	3.2	3.1	3.2	.043	1.247	3
	006	3.2	3.1	3.1	.042	1.235	2
Group 9	001	3.2	3.1	N/A	.027	1.232	8
	002	3.1	3.1	N/A	.021	1.238	16
	003	3.1	3.0	N/A	.029	1.236	
	004	3.0	3.0	N/A	.024	1.237	
	005	3.2	3.1	N/A	.030	1.238	

N/A - not applicable

DEPARTMENT OF THE NAVY
NAVAL WEAPONS SUPPORT CENTER
CRANE, INDIANA 47522

IN REPLY REFER TO:

3053-JDH:dsq
8900 - WPE

06 DEC 1979

From: Commanding Officer, Naval Weapons Support Center, Crane IN 47522
To: National Aeronautics and Space Administration, Goddard Space Flight Center (711), Greenbelt MD 20771

Subj: Report WQEC/C 79-114; Initial Evaluation Tests of General Electric Company 12 Ampere-Hour Nickel-Cadmium Spacecraft Cells with Design Variables

Ref: (a) NASA Purchase Order S-57075AG

Encl: (1) Report WQEC/C 79-114

1. In compliance with reference (a), enclosure (1) is forwarded for information and retention.

D. G. MILEY
By direction

Copy to:
Distribution List

TABLE VI
CHARGE RETENTION TEST DATA

	SERIAL NUMBER	END-OF-CHARGE			24 HR. OCV			1 WEEK OCV			END-OF-DISCHARGE		
		CELL (VOLTS)	AUX. ELECT. (VOLTS)	PRESS. (PSIA)	CELL (VOLTS)	AUX. ELECT. (VOLTS)	PRESS. (PSIA)	CELL (VOLTS)	AUX. ELECT (VOLTS)	PRESS. (PSIA)	CAPAC-ITY (AH)	AUX. ELECT. (VOLTS)	PRESS. (PSIA)
Group 1	001	1.469		52	1.367		2	1.326		1	13.5		1
	002	1.470			1.368			1.326			13.0		
	003	1.469			1.367			1.326			13.5		
	004	1.471		50	1.369		2	1.328		2	13.5		1
	005	1.468	.559	60	1.365	.010	5	1.324	.001	4	13.5	-.001	4
	006	1.471	.734	63	1.367	.099	10	1.324	.012	8	13.7	-.042	8
Group 4	001	1.468		40	1.366		9	1.320		9	12.5		9
	002	1.467			1.365			1.317			12.5		
	003	1.466			1.366			1.320			12.5		
	004	1.466		34	1.365		11	1.315		11	12.5		10
	005	1.467	.558	46	1.364	.007	13	1.321	.000	13	12.5	-.005	13
	006	1.467	.425	46	1.365	.051	7	1.321	.005	7	12.5	-.137	7
Group 7	001	1.476		41	1.346		8	1.309		7	15.3		6
	002	1.476		44	1.345		14	1.309		11	15.1		11
	003	1.477			1.344			1.309			15.4		
	004	1.476			1.344			1.308			14.9		
	005	1.478	.403	25	1.341	.018	5	1.306	.001	1	14.9	-.003	0
	006	1.480	.733	36	1.345	.248	10	1.309	.021	7	15.5	-.084	7
Group 8	001	1.479			1.344			1.309			15.4		
	002	1.486		49	1.344		18	1.308		9	15.6		8
	003	1.473			1.344			1.309			15.4		
	004	1.478		46	1.343		20	1.308		12	15.4		11
	005	1.481	.490	28	1.342	.020	12	1.308	.002	9	15.4	-.006	9
	006	1.484	.319	37	1.341	.035	23	1.306	.013	15	15.2	.004	14

TABLE VI
CHARGE RETENTION TEST DATA

	SERIAL NUMBER	END-OF-CHARGE			24 HR. OCV			1 WEEK OCV			END-OF-DISCHARGE		
		CELL (VOLTS)	AUX. ELECT. (VOLTS)	PRESS. (PSIA)	CELL (VOLTS)	AUX. ELECT. (VOLTS)	PRESS. (PSIA)	CELL (VOLTS)	AUX. ELECT (VOLTS	PRESS. (PSIA)	CAPAC-ITY (AH)	AUX. ELECT. (VOLTS)	PRESS. (PSIA)
Group 2	001	1.465			1.371			1.334			12.9		
	002	1.462			1.370			1.331			13.0		
	003	1.463		38	1.370		5	1.332		5	13.0		5
	004	1.463		46	1.370		6	1.333		6	13.0		5
	005	1.462	.449	38	1.370	.005	11	1.334	.001	11	13.0	-.017	11
	006	1.463	.414	32	1.370	.064	10	1.330	.004	9	13.2	-.024	9
Group 3	001	1.471			1.369			1.329			13.6		
	002	1.470		63	1.369		7	1.327		6	13.5		6
	003	1.469		52	1.369		11	1.330		11	13.5		11
	004	1.469			1.370			1.330			13.4		
	005	1.469	.531	51	1.370	.008	1	1.331	.000	1	13.4	-.005	1
Group 5	001	1.466		53	1.352		0	1.313		0	13.7		0
	002	1.467			1.352			1.314			13.7		
	003	1.468		64	1.354		6	1.316		5	13.7		5
	004	1.469			1.352			1.314			13.7		
	005	1.471	.342	60	1.358	.025	10	1.319	.002	9	13.7	-.012	8
	006	1.469	.568	53	1.353	.053	4	1.314	.010	4	13.7	-.014	4
Group 6	001	1.475			1.371			1.330			13.7		
	002	1.479		92	1.372		7	1.331		6	13.7		6
	003	1.475		92	1.370		13	1.330		12	13.5		12
	004	1.475			1.370			1.330			13.5		
	005	1.473	.424	74	1.370	.009	3	1.329	.000	3	13.7	-.003	3
	006	1.473	.587	48	1.370	.094	2	1.327	.005	2	14.5	-.059	2
Group 9	001	1.443		31	1.323		8	1.286		8	8.3		8
	002	1.445		41	1.332		17	1.296		17	9.0		16
	003	1.442			1.329			1.295			9.1		
	004	1.443			1.330			1.296			9.3		
	005	1.442			1.330			1.296			9.1		

TABLE VII
Charge Efficiency and Overcharge Data

	SERIAL NUMBER	Charge Efficiency (20°C) END-OF-CHARGE CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	END-OF-DISCHARGE CAPACITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	Overcharge Test (0°) END-OF-CHARGE CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	END-OF-DISCHARGE CAPACITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	Overcharge Test (35°C) END-OF-CHARGE CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	END-OF-DISCHARGE CAPACITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)
Group 1	001	1.372		1	3.9		1	1.496		40	14.5		14	1.418		37	15.9		3
	002	1.373			3.9			1.496			14.5			1.419			15.9		
	003	1.372			3.9			1.496			14.5			1.418			15.9		
	004	1.371		1	3.4		1	1.496		39	14.6		14	1.416		36	16.1		3
	005	1.372	.006	4	3.9	-.005	4	1.495	.409	49	14.3	.119	21	1.417	.655	36	15.6	.068	6
	006	1.371	.046	8	3.4	.040	8	1.497	.519	50	14.6	.235	27	1.419	.748	39	16.0	.239	13
Group 4	001	1.377		9	3.9		9	1.490		38	12 8		18	1.424		40	14.1		11
	002	1.376			3.9			1.492			13.0			1.424			14.2		
	003	1.376			3.9			1.490			13.3			1.423			14.2		
	004	1.376		11	3.9		10	1.490		32	13.3		17	1.424		29	14.1		13
	005	1.376	.005	13	3.9	.001	12	1.491	.300	40	13.0	.090	22	1.421	.640	34	14.0	.042	13
	006	1.376	.025	7	3.9	.000	7	1.492	.562	37	13.0	.134	17	1.424	.716	35	14.1	.279	10
Group 7	001	1.370		6	4.0		6	1.576 *		64	16.6		55	1.396		51	14.5		32
	002	1.370		10	3.5		10	1.578 *		70	16.8		61	1.396		54	14.6		37
	003	1.370			3.5			1.578 *			16.8			1.396			14.5		
	004	1.370			3.8			1.578 *			16.6			1.396			14.6		
	005	1.371	.025	0	3.5	.018	0	1.582 *	.206	65	16.6	.013	58	1.396	.192	42	14.0	.032	31
Group 8	006	1.369	.191	7	3.5	.122	7	1.575 *	.629	71	17.1	.276	64	1.395	.706	59	14.6	.123	38
	001	1.368			3.1			1.578 *			16.2			1.398			15.1		
	002	1.370		6	2.9		6	1.590 *		62	16 4		28	1.401		27	15.4		19
	003	1.368			3.1			1.579 *			16.2			1.398			15.1		
	004	1.369		10	3.1		10	1.583 *		70	16.0		38	1.398		36	14.7		29
	005	1.368	.077	8	3.1	.015	8	1.578 *	.281	58	16.0	.004	42	1.395	.364	44	14.0		32
	006	1.368	.058	12	3.1	.046	12	1.577 *	.240	73	16.0	.016	56	1.394	.324	52	13.9		37

9ND-NADC (SP 11/73) *- charge terminated because of high cell voltages, Average AH_in: Group 7 (21.8) Group 8 (22.0)

TABLE VII

Charge Efficiency and Overcharge Data

	SERIAL NUMBER	Charge Efficiency (20°C)						Overcharge Test (0°)						Overcharge Test (35°C)					
		END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE		
		CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)
Group 2	001	1.373			4.7			1.486			13.7			1.418			16.0		
	002	1.372			4.4			1.482			13.9			1.417			16.1		
	003	1.373		4	4.8		4	1.481		36	13.7		15	1.417		17	16.0	-	5
	004	1.373		5	4.7		5	1.481		43	13.9		19	1.416		19	16.1		7
	005	1.373	.001	11	4.7	.000	11	1.480	.372	37	13.7	.079	13	1.417	.282	19	16.0	.002	12
	006	1.372	.025	9	4.5	.005	9	1.485	.303	28	14.2	.156	12	1.415	.297	14	16.2	.079	10
Group 3	001	1.373			4.0			1.494			14.7			1.420			16.0		
	002	1.372		6	4.3		6	1.494		52	14.5		17	1.416		33	15.8		8
	003	1.373		10	4.1		10	1.492		41	14.7		17	1.417		32	16.0		12
	004	1.373			4.3			1.493			14.6			1.417			15.8		
	005	1.373	.001	1	4.2	-.027	1	1.492	.386	40	14.6	.124	8	1.417	.544	28	15.7	.013	2
Group 5	001	1.375		0	4.5		0	1.505		32	14.9		10	1.398		29	13.4		0
	002	1.375			4.1			1.508			14.8			1.397			13.1		
	003	1.375		5	4.1		5	1.503		40	14.8		18	1.404		38	15.0		7
	004	1.375			4.0			1.509			15.1			1.400			13.8		
	005	1.376	.032	8	4.1	.007	8	1.502	.142	43	14.6	.031	20	1.410	.525	33	15.6	.024	10
	006	1.375	.080	4	4.0	.015	4	1.509	.343	31	14.8	.115	10	1.400	.602	35	13.9	.124	5
Group 6	001	1.374			4.2			1.497			14.9			1.416			16.1		
	002	1.374		6	4.2		6	1.499		83	15.0		33	1.415		25	15.9		7
	003	1.374		12	4.4		12	1.496		80	14.6		33	1.415		35	15.9		14
	004	1.374			4.4			1.498			14.2			1.415			15.8		
	005	1.374	.004	3	4.3	.002	3	1.495	.239	65	14.9	.054	25	1.415	.339	20	16.1	.009	6
	006	1.374	.063	2	4.2	.035	2	1.496	.484	49	15.2	.152	14	1.415	.491	15	16.1	.065	4

81

SND-NADC (SP 11/73)

WBL/L 75-114

TABLE VII

Charge Efficiency and Overcharge Data

SERIAL NUMBER	Charge Efficiency (20°C)						Overcharge Test (0°)						Overcharge Test (35°C)					
	END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE		
	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC-ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)
001	1.377		8	2.9		8	1.492		42	9.6		24	1.397		27	9.3		11
002	1.378		16	3.1		16	1.494		49	10.2		28	1.398		26	9.6		13
003	1.376			3.1			1.497			10.4			1.392			9.3		
004	1.377			3.1			1.495			10.6			1.393			9.5		
005	1.377			3.1			1.492			10.4			1.393			9.3		

Group 9

19

9ND-NADC (SP 11/73)

WQEC/C 79-114

TABLE VIII
PRESSURE VS. CAPACITY TEST DATA

Serial No.	001	004	005	006	001	004	005	006	001	002	005	006	002	004	005	006
Start-of-Charge, Press.	1	2	4	10	10	12	13	8	19	20	9	18	7	14	15	19
AH in to 5 PSIA	18.4	18.3	17.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cell (volts)	1.520	1.505	1.476													
Aux (volts)			.297													
AH in to 10 PSIA	18.9	18.7	18.4	N/A	N/A	N/A	N/A	15.8	N/A		20.2	N/A	20.5	N/A	N/A	N/A
Cell (volts)	1.540	1.528	1.520					1.489			1.521		1.526			
Aux (volts)			.592					.309			.067					
AH in to 15 PSIA	19.1	19.0	18.6	19.0	16.0	16.4	15.6	16.3	N/A		N/A	N/A	21.0	20.3	N/A	N/A
Cell (volts)	1.545	1.536	1.530	1.534	1.498	1.514	1.479	1.517					1.546	1.513		
Aux (volts)			.631	.505			.364	.379								
AH in to 20 PSIA	19.5	19.3	19.1	19.3	16.7	16.9	16.3	16.4	18.6		N/A	20.2	N/A	21.2	21.2	19.0
Cell (volts)	1.548	1.543	1.545	1.542	1.528	1.530	1.520	1.522	1.469			1.492		1.549	1.539	1.473
Aux (volts)			.681	.572			.582	.401				.268			.307	.090
AH in to V/L (1.55V)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		20.9	N/A	21.2	N/A	N/A	N/A
Aux (volts)											.165					
Press (PSIA)											14		19			
30 Min OCV, Cell	1.415	1.419	1.412	1.420	1.415	1.415	1.415	1.416	1.383		1.386	1.382	1.387	1.386	1.385	1.384
Aux (volts)			.506	.537			.482	.488			.077	.266			.143	.076
Press (PSIA)	27	24	26	27	NA	NA	NA	NA	NA		20	20	22	23	22	20
1 hour OCV, Cell	NA	1.409	NA	1.411	1.403	1.403	1.400	1.403	1.378		1.380	1.378	1.379	1.378	1.378	1.378
Aux (volts)				.526			.468	.321			.055	.261			.086	.077
Press (PSIA)		21		27	24	22	21	23	21		14	20	22	23	22	20
EOD AH out	15.9	15.5	15.4	15.3	13.6	13.6	13.6	13.6	15.3		17.2	16.5	17.6	17.6	17.6	15.3
Aux (volts)			.111	.224			.007	.114			.003	.087			.003	.031
Press (PSIA)	3	3	6	13	12	13	14	9	20		13	18	19	21	20	20
	Group 1				Group 4				Group 7				Group 8			

N/A - not applicable
NA - not Available

9ND-NADC (SP 11/73)

TABLE VIII
PRESSURE VS. CAPACITY TEST DATA

Serial No.	003	004	005	006	002	003	005	001	003	005	006	002	003	005	006	
Start-of-Charge, Press.	4	5	1	5	1	4	4	0	5	6	4	5	4	2	3	
AH in to 5 PSIA	15.0	N/A	18.4	N/A	18.1	16.7	17.4	19.6	N/A	N/A	17.4	N/A	15.7	18.2	18.2	
Cell (volts)	1.441		1.499		1.507	1.459	1.477	1.532			1.465		1.444	1.492	1.492	
Aux (volts)			.237				.163				.183			.137	.370	
AH in to 10 PSIA	18.1	17.9	19.1	18.1	18.6	18.4	18.4	19.7	18.8	18.8	19.1	18.4	18.2	18.6	18.6	
Cell (volts)	1.496	1.484	1.514	1.495	1.529	1.514	1.520	1.536	1.508	1.518	1.519	1.510	1.495	1.515	1.514	
Aux (volts)			.325	.279			.321			.498	.402			.197	.428	
AH in to 15 PSIA	18.8	18.8	19.5	18.8	18.8	18.8	18.8	20.1	19.3	19.3	19.6	18.9	18.9	18.9	18.9	
Cell (volts)	1.516	1.512	1.515	1.513	1.536	1.533	1.536	1.545	1.530	1.539	1.540	1.526	1.522	1.522	1.520	
Aux (volts)			.378	.354			.488			.578	.458			.223	.456	
AH in to 20 PSIA	19.3	19.3	19.9	19.5	19.1	19.1	19.1	20.3	19.7	19.6	19.9	19.1	19.1	19.1	19.2	
Cell (volts)	1.518	1.518	1.514	1.519	1.540	1.538	1.540	1.548	1.540	1.545	1.545	1.530	1.527	1.526	1.523	
Aux (volts)			.411	.387			.547			.601	.504			.253	.526	
AH in to V/L (1.55V)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Aux (volts)																
Press (PSIA)																
30 Min OCV, Cell	1.411	1.411	1.408	1.412	1.415	1.415	1.413	1.406	1.406	1.407	1.406	1.418	1.417	1.416	1.417	
Aux (volts)			.384	.328			.493			.340	.435			.286	.463	
Press (PSIA)	23	22	18	19	26	26	26	24	27	24	23	26	27	23	21	
1 hour OCV, Cell	1.402	1.401	1.401	1.403	1.407	1.406	1.405	1.397	1.396	1.397	1.396	1.408	1.406	1.405	1.407	
Aux (volts)			.342	.304			.467			.278	.408			.267	.420	
Press (PSIA)	21	20	13	16	25	26	24	21	24	22	21	25	25	21	17	
EOD AH out	15.6	15.6	15.6	15.6	15.7	15.7	15.7	16.1	15.9	15.9	15.9	15.8	15.8	15.8	15.8	
Aux (volts)																
Press (PSIA)	8	8	2	7	4	8	7	0	7	8	5	8	7	4	4	
	Group 2				Group 3			Group 5				Group 6				

N/A - not applicable

9ND-NADC (SP 11/73)

TABLE VIII
PRESSURE VS. CAPACITY TEST DATA

Serial N.	004	005														
Start-of-Charge, Press.	8	9														
AH in to 5 PSIA	N/A	N/A														
Cell (volts)																
Aux (volts)																
AH in to 10 PSIA	12.0	12.2														
Cell (volts)	1.460	1.457														
Aux (volts)	NA	NA														
AH in to 15 PSIA	13.0	13.2														
Cell (volts)	1.482	1.478														
Aux (volts)																
AH in to 20 PSIA	13.5	13.7														
Cell (volts)	1.491	1.487														
Aux (volts)																
AH in to V/L (1.55V)	NA	NA														
Aux (volts)																
Press (PSIA)																
30 Min OCV, Cell	1.379	1.380														
Aux (volts)																
Press (PSIA)	23	22														
1 hour OCV, Cell	1.370	1.370														
Aux (volts)																
Press (PSIA)	21	21														
EOD AH out	10.1	10.3														
Aux (volts)																
Press (PSIA)	11	13														

N/A - not applicable

Group 9

9ND-NADC (SP 11/73)

Group I

GE-NADC (SP 11/73)

TABLE IX

SPECIAL RESISTANCE CHARACTERISTIC DATA ON THE AUXILIARY ELECTRODES

SERIAL NO.	005		006		Power - 005		Power - 006				AVERAGE	
OHMS	VOLTS	PRESS	VOLTS	PRESS	[redacted]	PRESS	VOLTS	PRESS	VOLTS	PRESS	VOLTS	MILLIWATTS
10,000	.928	19	.891	16	.086		.079					
5,000	.916	18	.804	16	.168		.129					
2,000	.895	18	.762	16	.401		.290					
1,000	.870	18	.717	17	.757		.514					
500	.840	18	.568	18	1.411		.645					
200	.785	18	.426	18	3.081		.907					
100	.732	18	.311	17	5.358		.967					
50	.676	17	.211	17	9.140		.890					
20	.571	17	.122	16	16.302		.744					
10	.479	17	.079	17	27.944		.624					
5	.381	17	.038	16	29.032		.288					
2	.238	16	.017	16	28.324		.144					
1	.168	16	.008	17	28.22		.064					
0.5	.111	14	.003	16	24.642		.018					
0.2	.079	14	.001	16	31.205		.005					
0.1	.066	14	.001	17	43.560		.010					

Note: All pressures in PSIA.

$$\text{POWER} = \frac{V^2}{R} \text{ Watts} \quad 10^3 \frac{\text{Milliwatts}}{\text{Watt}} : \text{Milliwatts}$$

Group 4
RTD-RADC (SP 11/73)

TABLE IX
SPECIAL RESISTANCE CHARACTERISTIC DATA ON THE AUXILIARY ELECTRODES

SERIAL NO.	005		006		Power-005		Power-006				AVERAGE	
OHMS	VOLTS	PRESS	VOLTS	PRESS	[redacted]	PRESS	VOLTS	PRESS	VOLTS	PRESS	VOLTS	MILLIWATTS
10,000	.907	20	.739		.082		.055					
5,000	.896	20	.670		.161		.089					
2,000	.874	20	.543		.381		.147					
1,000	.845	20	.420		.714		.176					
500	.814	20	.280		1.325		.157					
200	.755	20	.131		2.850		.086					
100	.703	20	.074		4.942		.055					
50	.648	19	.049		8.398		.048					
20	.544	19	.027		14.797		.036					
10	.449	19	.017		20.160		.029					
5	.347	19	.011		24.082		.024					
2	.205	19	.009		21.013		.040					
1	.142	18	.005		20.164		.025					
0.5	.082	18	.002		13.448		.008					
0.2	.049	18	.001		12.005		.005					
0.1	.037	17	.001		13.690		.010					

Note: All pressures in PSIA.

$$\text{POWER} = \frac{V^2}{R} \text{ Watts} \quad 10^3 \frac{\text{Milliwatts}}{\text{Watt}} : \text{Milliwatts}$$

Group 7
GTD-NADC (SF 11/73)

TABLE IX

SPECIAL RESISTANCE CHARACTERISTIC DATA ON THE AUXILIARY ELECTRODES

SERIAL NO.	005		006		Power-005		Power-006				AVERAGE	
OHMS	VOLTS	PRESS	VOLTS	PRESS	[redacted]	PRESS	VOLTS	PRESS	VOLTS	PRESS	VOLTS	MILLIWATTS
10,000	.884	19	.817	25	.078		.067					
5,000	.871	19	.815	25	.152		.133					
2,000	.845	19	.814	25	.357		.331					
1,000	.811	19	.802	25	.658		.643					
500	.767	19	.754	25	1.177		1.137					
200	.697	19	.646	25	2.429		2.087					
100	.634	19	.544	25	4.019		2.96					
50	.559	19	.420	25	6.250		3.53					
20	.430	19	.252	25	9.25		3.18					
10	.323	19	.116	25	10.43		1.35					
5	.221	19	.090	25	9.77		1.62					
2	.117	19	.042	25	6.84		.882					
1	.070	19	.024	25	4.90		.576					
0.5	.043	19	.014	25	3.69		.392					
0.2	.025	19	.008	25	3.13		.320					
0.1	.019	19	.006	25	3.61		.360					

Note: All pressures in PSIA.

$$\text{POWER} = \frac{V^2}{R} \text{ Watts} \quad 10^3 \frac{\text{Milliwatts}}{\text{Watt}} : \text{Milliwatts}$$

Group 8
AID-NADC (SE 11/73)

TABLE IX
SPECIAL RESISTANCE CHARACTERISTIC DATA ON THE AUXILIARY ELECTRODES

SERIAL NO.	005		006		Power - 005		Power - 006				AVERAGE	
OHMS	VOLTS	PRESS	VOLTS	PRESS	[redacted]	PRESS	VOLTS	PRESS	VOLTS	PRESS	VOLTS	MILLIWATTS
10,000	.889	22	.821	24	.079		.067					
5,000	.876	22	.759	24	.153		.115					
2,000	.849	22	.654	24	.360		.214					
1,000	.815	22	.523	24	.664		.274					
500	.771	22	.380	24	1.189		.289					
200	.707	22	.221	24	2.499		.244					
100	.652	22	.149	24	4.251		.222					
50	.588	22	.091	24	6.915		.166					
20	.482	22	.049	24	11.616		.120					
10	.385	22	.029	24	14.823		.084					
5	.283	22	.012	24	16.018		.029					
2	.163	21	.006	24	13.285		.018					
1	.103	21	.005	24	10.609		.025					
0.5	.066	20	.003	24	8.712		.018					
0.2	.040	20	.000	24	8.000		.000					
0.1	.031	19	.000	24	9.61		.000					

Note: All pressures in PSIA.

$$\text{POWER} = \frac{V^2}{R} \text{ Watts } 10^3 \frac{\text{Milliwatts}}{\text{Watt}} : \text{Milliwatts}$$

APPENDIX I

I. TEST PROCEDURE

A. Phenolphthalein Leak Tests:

1. This test is a determination of the condition of the welds and ceramic seals on receipt of the cells and following the last discharge of the cells (Cycle #8).

2. The cells were initially checked with a one-half of one percent phenolphthalein solution applied with a cotton swab and then placed in a vacuum chamber and exposed to a vacuum of 40 microns of mercury or less for 24 hours. Upon removal they were rechecked for leaks and then received a final check following test completion. The requirement is no red or pink discoloration which indicates a leak.

B. Capacity Tests:

1. The capacity test is a determination of the cells' capacity at the C/2 discharge rate to 0.75 volt per cell, where C is the manufacturer's rated capacity. This type discharge follows all charges of this evaluation test.

2. The charges for the capacity tests are as follows:

a. C/20, 48 hours, room ambient (RA), Cycle 0, with a test limit of 1.52 volts or pressure of 100 psia.

b. C/10, 24 hours, RA, Cycle 1, with a test limit of 1.52 volts or 100 psia pressure and a requirement of maximum voltage (1.48) or pressure (75 psia).

c. C/10, 24 hours, 20° C, Cycle 2, with the same limits and requirements as the charge of Cycle 1.

C. Internal Resistance:

1. Measurements are taken across the cell terminals 1/2 hour before the end-of-charge (EOC) on Cycle 1, and 1 and 2 hours after the start-of-discharge of Cycle 2. These measurements were made with a Hewlett-Packard milliohmeter (Model 4328A).

D. Special Charge Retention Test, 20°C:

1. This test is to establish the capacity retention of each cell following a 7-day open-circuit-stand in a charge mode.

2. The cells are charged at C/10 for 24 hours with a test limit of 1.52 volts or 100 psia pressure. They then stand on open-circuit for 7 days, with the requirement that the open-circuit voltage of each cell, following this period, is within ±5 millivolts of the average cell voltage. The cells are then discharged and 80 percent capacity out of that obtained in Cycle 3 is required.

E. Internal Short Test:

1. This test is a means of detecting slight shorting conditions which may exist because of imperfections in the insulating materials, or damage to element in handling or assembly.

2. Following completion of the third capacity discharge, the cells are shunted with a 0.5-ohm, 3-watt resistor for 16 hours. At the end of 16 hours the resistors are removed and the cells stand on open-circuit-voltage (OCV) for 24 hours. A minimum voltage of 1.15 is required at the end of the 24 hours.

F. Charge Efficiency Test, 20° C:

1. This test is a measurement of the cells' charge efficiency when charged at a low current rate.

2. The cells are charged at C/40 for 20 hours with a test limit of 1.52 volts or 100 psia pressure. They are then discharged and the requirement is that the minimum capacity out equals 55 percent of capacity in during the preceding charge.

G. Overcharge Test #1, 0° C:

1. The purpose of this test is to determine the degree to which the cells will maintain a balanced voltage, and to determine the cells' capability to be overcharged without overcharging the negative electrode.

2. The cells are charged at C/20 for 60 hours. The test limits are cell voltages of 1.56 or greater for a continuous time period of 2 hours or pressures of 100 psia. The requirement is a voltage of 1.520 or a pressure of 75 psia. The cells are then discharged and 85 percent capacity out of that obtained in Cycle 3 is required.

H. Overcharge Test #2, 35° C:

1. This test is a measurement of the cells' capacity at a higher temperature when compared to its capacity at 20° C. This test also determines the cells' capability of reaching a point of pressure equilibrium; oxygen recombination at the negative plate at the same rate it is being generated at the positive plate.

2. The cells are charged C/10 for 24 hours with a test limit of 1.52 volts or 100 psia pressure and a requirement of 1.45 volts or 75 psia pressure. The cells are then discharged and 55 percent capacity out of that obtained in Cycle 3 is required.

I. Pressure versus Capacity Test:

1. The purpose of this test is to determine the capacity to a pressure and the pressure decay during charge and open circuit stand respectively.

2. Each cell is charged at C/2 to either a pressure of 20 psia or a voltage of 1.550. Recordings are taken on each cell when it reaches 5, 10, 15 and 20 psia pressure. The cells then stand OCV for 1 hour with 30-minute recordings and then are discharged, shorted out and leak tested.

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37

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